



333 SW Fifth Avenue, Suite 600
 Portland, OR 97204
 Tel: (503) 248-5600 Fax: (503) 345-6821

MEMORANDUM

Date: November 12, 2020

To: Linda Ader, START-IV Team Leader, E & E, a member of WSP, Seattle, WA *LEA*

From: Kathryn White, Fisheries Biologist, E & E, a member of WSP, Portland, OR *KW*

Subject: Bradford Island Landfill Sensitive Environments
 Cascade Locks, Oregon

Ref: Contract Number: EP-S7-13-07
 Task Order: 68HE0720F0023

This memorandum provides sensitive environment information for Bradford Island Landfill located on Bradford Island within the Columbia River and near Cascade Locks, Oregon. Specifically, this memorandum addresses such occurrences within the 15-mile Target Distance Limit (TDL) within the Columbia River and/or within the documented Zone of Actual Contamination on the northern side of Bradford Island, as depicted in attached Figures 6 and 5, respectively, from the Hazard Ranking System Documentation Record associated with this project.

Five fish species, Bull trout (*Salvelinus confluentus*), Chum salmon (*Oncorhynchus keta*), Steelhead salmon (*Oncorhynchus mykiss*), Coho salmon (*Oncorhynchus kisutch*), and Chinook salmon (*Oncorhynchus tshawytscha*) are federally listed under Endangered Species Act (ESA) as threatened and occur within the 15-mile Target Distance Limit (TDL) on the Columbia River (NMFS 2016). Two fish species, White sturgeon (*Acipenser transmontanus*) and Sockeye salmon (*Oncorhynchus nerka*) are federally listed under ESA as endangered and occur within the 15-mile TDL. The Columbia River within the 15-mile TDL is a major migratory pathway and contains critical spawning habitat required for population maintenance for summer and spring Steelhead salmon, fall and spring Chinook salmon, and Coho salmon. A critical migratory pathway for Bull trout, Sockeye salmon, summer Chinook, and fall Chum is expected to exist within the Zone of Actual Contamination as these species migrate to and/or from critical spawning habitats. White Sturgeon and Rainbow trout (a life stage of Steelhead salmon) are both resident fish species and have multiple uses within the Zone of Actual Contamination.

Steelhead have the most complex life history of any species of Pacific salmon. Steelhead can be freshwater residents (referred to as 'rainbow trout') or anadromous (referred to as 'steelhead'). Many State and Federal departments use both 'Rainbow trout' and 'Steelhead salmon' when collecting data. Both resident and anadromous forms of Steelhead may repeatedly spawn, compared to other Pacific salmon that spawn then die (Satterthwaite et al. 2009). Thorpe (2007) identified 32 potential life history trajectories for steelhead. This presents further management challenges with Steelhead salmon.

The National Marine Fisheries Service monitored and distinguished the Evolutionary Significant Unit (ESUs) and Distinct Population Segment (DPSs) for Pacific salmon and steelhead in the late 1990s (Ford 2011). The habitat known as the Lower Columbia River within the 15-mile TDL is the designated critical habitat and the ESU for Chinook salmon, Chum salmon, Coho salmon, and Steelhead (NMFS 2016). The ESA listing units and the endangered and threatened species found within the 15-mile TDL and Zone of

Bradford Island Landfill
Sensitive Environments

Actual Contamination are listed in Tables 1 and 2 (ODFW Compass; Washington Geospatial Open Data Portal).

Table 1 Endangered Species Act (ESA) Listing Units Presence		
ESA Listing Units	Present within Zone of Actual Contamination (Y/N)	Present within 15-mile Target Distance Limit (Y/N)
Spring Chinook ESU	Y	Y
Summer Chinook ESU	Y	Y
Fall Chinook ESU	Y	Y
Fall Chum ESU	Y	Y
Winter Chum ESU	Y	Y
Coho ESU	Y	Y
Winter Steelhead DPS	Y	Y
Summer Steelhead DPS	Y	Y

Table 2 Sensitive Environments							
Common Name, Scientific Name, and Population	Federal Status	State Status	Designated Critical Habitat (Y/N)	Present within Zone of Actual Contamination (Y/N)	Present within 15-mile Target Distance Limit (Y/N)	Distribution and Life History	Reference
Bull trout (<i>Salvelinus confluentus</i>)	Threatened	Candidate (Washington)	Y	Y	Y	Documented presence, migration, and overwintering throughout TDL	ODFW n.d.; WDFW n.d.
Chum salmon (<i>Oncorhynchus keta</i>) Lower Columbia River ESU	Threatened	Candidate (Washington)	Y	Y	Y	Documented and historic presence, migration, and spawning throughout TDL, two potential blocked streams below dam	ODFW n.d.; WDFW n.d.; NMFS 2016
Steelhead salmon (<i>Oncorhynchus mykiss</i>) Lower Columbia River ESU	Threatened	Candidate (Washington)	Y	Y	Y	Documented and historical presence, spawning, rearing, migration, and resident with multiple uses throughout TDL	ODFW n.d.; WDFW n.d.; NMFS 2016
Coho salmon (<i>Oncorhynchus kisutch</i>) Lower Columbia River ESU	Threatened	Endangered (Oregon)	Y	Y	Y	Documented, presumed, and historic presence, spawning, and rearing throughout TDL, four potential blocked streams below dam	ODFW n.d.; WDFW n.d.; NMFS 2016

Bradford Island Landfill
Sensitive Environments

Table 2 Sensitive Environments							
Common Name, Scientific Name, and Population	Federal Status	State Status	Designated Critical Habitat (Y/N)	Present within Zone of Actual Contamination (Y/N)	Present within 15-mile Target Distance Limit (Y/N)	Distribution and Life History	Reference
Chinook salmon (<i>Oncorhynchus tshawytscha</i>) Lower Columbia River ESU	Threatened	Candidate (Washington)	Y	Y	Y	Documented and historical presence, migration, spawning, and rearing throughout TDL, one potentially blocked stream below dam	ODFW n.d.; WDFW n.d.; NMFS 2016
White Sturgeon (<i>Acipenser transmontanus</i>)	Endangered	Candidate (Washington)	N	Y	Y	Spawning and resident with multiple uses throughout TDL, resident with multiple uses above dam	USFWS n.d.; ODFW n.d.
Sockeye salmon (<i>Oncorhynchus nerka</i>)	Endangered	Candidate (Washington)	Y	Y	Y	Documented and historical presence throughout TDL	ODFW n.d.; WDFW n.d.

Key:

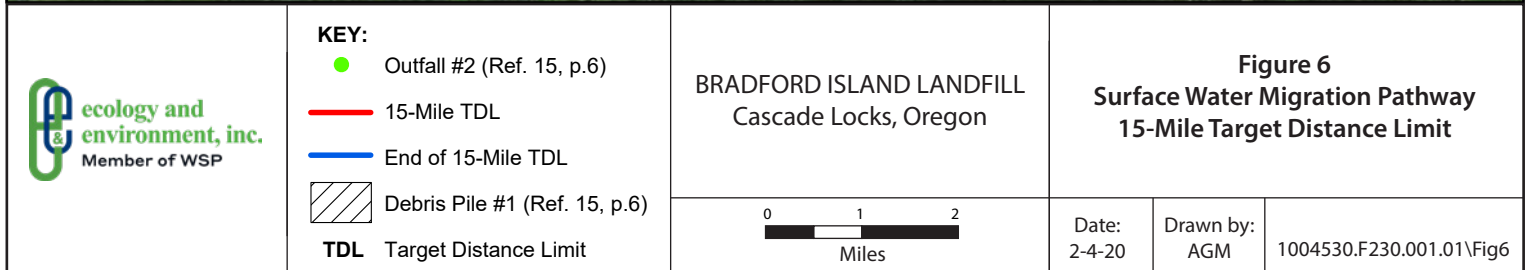
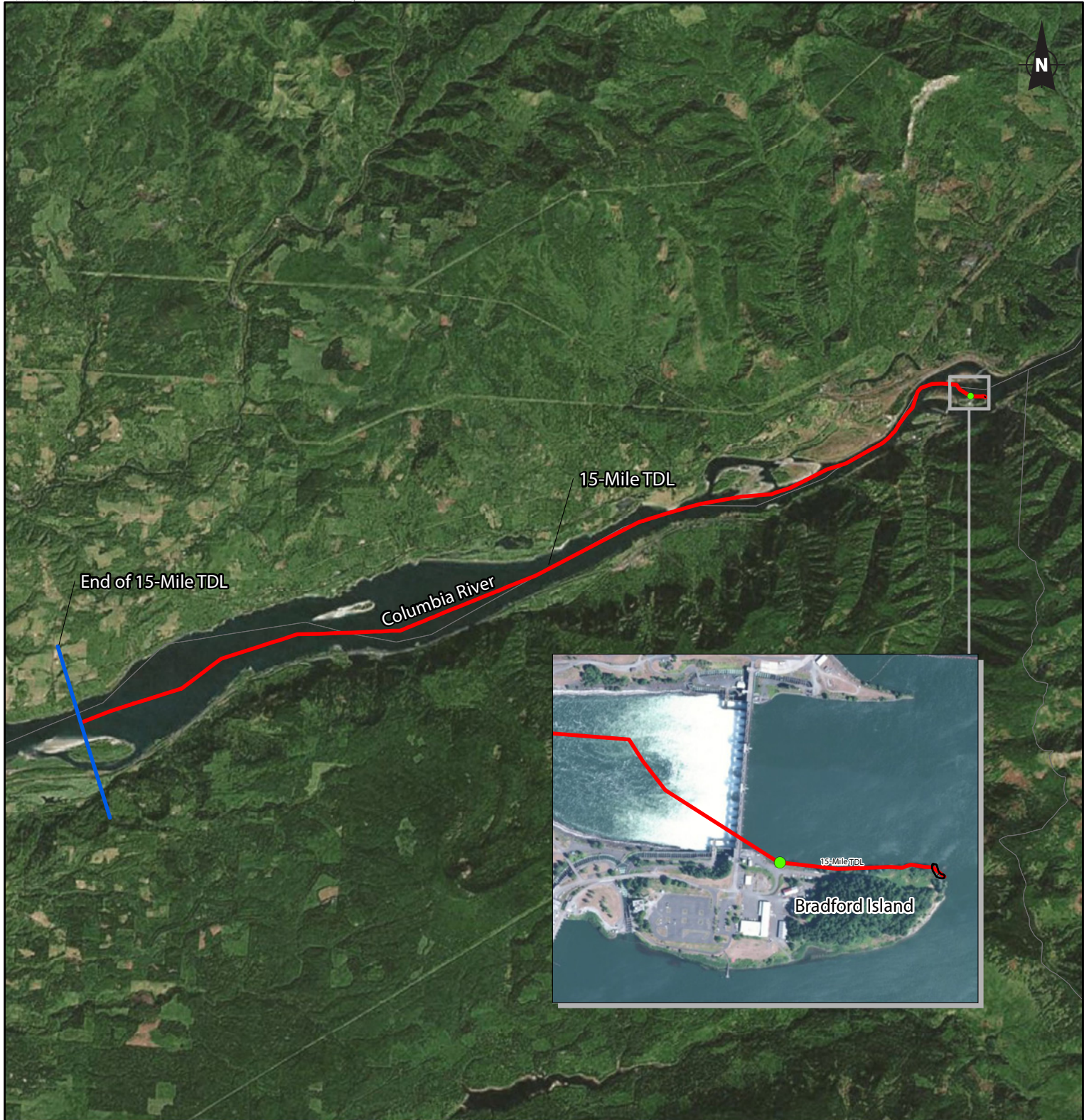
TDL – Target Distance Limit.

Reference List:

- U.S. Fish and Wildlife Service (USFWS). n.d. *Endangered Species*. Available at: <https://www.fws.gov/endangered/>. Accessed March 4, 2020.
- Ford, M.J. (ed.). 2011. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. *Status Review Update for Pacific Salmon and Steelhead Listed under the Endangered Species Act: Pacific Northwest.*, NOAA Technical Memorandum, NMFS-NWFSC-113. November 2011. 307 total pages, 20 pages excerpted inclusive of the Table of Contents and pages 8 and 9.
- National Marine Fisheries Service (NMFS). 2016. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, West Coast Region, Portland, Oregon. *2016 5-Year Review: Summary & Evaluation of Lower Columbia River Chinook Salmon, Columbia River Chum Salmon, Lower Columbia River Coho Salmon, Lower Columbia River Steelhead*. 87 total pages, 11 pages excerpted inclusive of the Table of Contents and pages 1 through 5.
- Oregon Department of Fish and Wildlife (ODFW). n.d. *Threatened, Endangered, and Candidate Fish and Wildlife Species*. Available at: https://www.dfw.state.or.us/wildlife/diversity/species/threatened_endangered_candidate_list.asp. Accessed March 4, 2020.
- Oregon Department of Fish and Wildlife (ODFW). n.d. *Compass Mapping Tool*. Available at: <https://compass.dfw.state.or.us/visualize/#x=-116.04&y=41.74&z=5&logo=true&dls%5B%5D=true&dls%5B%5D=0.5&dls%5B%5D=549&basemap=ESRI+Satellite&tab=data&print=false>. Accessed March 4, 2020.
- Satterthwaite, W.H., M.P. Beakes, E.M. Collins, D.R. Swank, J.E. Merz, R.G. Titus, S.M. Sogard, and M. Mangel. 2009. *Steelhead Life History on California's Central Coast: Insights from a State-Dependent Model*. Article in: Transactions of the American Fisheries Society. May 2009. Volume 138. 18 pages.
- Thorpe, J. E. 2007. *Maturation responses of salmonids to changing developmental opportunities*. Article in: Marine Ecology Progress Series. April 16, 2007. Volume 335. 4 pages.
- Washington Department of Fish and Wildlife (WDFW). n.d. *Threatened and Endangered Species*. Available at: <https://wdfw.wa.gov/species-habitats/at-risk/listed>. Accessed March 4, 2020.
- Washington Geospatial Open Data Portal. n.d. *SalmonScape*. Available at: <http://geo.wa.gov/datasets/1e56a648718543ab952e75ff9971f086>. Accessed March 4, 2020.

FIGURES





Note: Feature labels, TDL-related lines, Outfall #2, and Debris Pile #1 added to basemap by Ecology and Environment, Inc., a member of WSP

REFERENCES



Status Review Update for Pacific Salmon and Steelhead Listed under the Endangered Species Act: Pacific Northwest

November 2011

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service

NOAA Technical Memorandum NMFS-NWFSC Series

The Northwest Fisheries Science Center of the National Marine Fisheries Service, NOAA, uses the NOAA Technical Memorandum NMFS-NWFSC series to issue scientific and technical publications. Manuscripts have been peer reviewed and edited. Documents published in this series may be cited in the scientific and technical literature.

The NMFS-NWFSC Technical Memorandum series of the Northwest Fisheries Science Center continues the NMFS-F/NWC series established in 1970 by the Northwest & Alaska Fisheries Science Center, which has since been split into the Northwest Fisheries Science Center and the Alaska Fisheries Science Center. The NMFS-AFSC Technical Memorandum series is now used by the Alaska Fisheries Science Center.

Reference throughout this document to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

This document should be referenced as follows:

M.J. Ford (ed.). 2011. Status review update for Pacific salmon and steelhead listed under the Endangered Species Act: Pacific Northwest. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-113, 281 p.



Status Review Update for Pacific Salmon and Steelhead Listed under the Endangered Species Act: Pacific Northwest

Edited by Michael J. Ford

From contributions by the editor and Andrew Albaugh, Katie Barnas, Tom Cooney, Jeff Cowen, Jeffrey J. Hard, Robert G. Kope, Michelle M. McClure, Paul McElhany, James M. Myers, Norma J. Sands, David Teel, and Laurie A. Weitkamp

Northwest Fisheries Science Center
2725 Montlake Boulevard East
Seattle, Washington 98112

November 2011

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service

**Most NOAA Technical Memorandums
NMFS-NWFSC are available at the
Northwest Fisheries Science Center
Web site, <http://www.nwfsc.noaa.gov>**

Copies are also available from the
National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Phone orders: 1-800-553-6847
E-mail orders: orders@ntis.fedworld.gov

Table of Contents

List of Figures	v
List of Tables	xiii
Executive Summary	xvii
Acknowledgments.....	xix
Abbreviations and Acronyms	xxi
Introduction and Summary of Conclusions	1
Methods	5
ESU Boundaries.....	7
<i>By James M. Myers, Laurie A. Weitkamp, and David Teel</i>	
ESU and DPS Definition.....	7
New Information	8
Coho Salmon—Puget Sound and Washington Coast ESUs.....	9
Lower Columbia River and Middle Columbia River Boundaries	19
Interior Columbia River Domain Status Summaries	29
<i>By Tom Cooney</i>	
Upper Columbia River Spring-run Chinook Salmon ESU.....	29
Upper Columbia River Steelhead ESU	41
Middle Columbia River Steelhead DPS	52
Snake River Spring/Summer-run Chinook Salmon ESU	71
Snake River Fall-run Chinook Salmon ESU	91
Snake River Sockeye Salmon ESU	100
Snake River Basin Steelhead ESU	108
Willamette/Lower Columbia River Domain Status Summaries	125
<i>By Paul McElhany</i>	
Lower Columbia River Chinook Salmon ESU.....	125
Upper Willamette River Chinook Salmon ESU	137
Columbia River Chum Salmon ESU	145
Lower Columbia River Coho Salmon ESU.....	152
Lower Columbia River Steelhead ESU.....	166
Upper Willamette River Steelhead ESU	174

Puget Sound/Lake Ozette Domain Status Summaries	181
Puget Sound Chinook Salmon ESU	181
<i>By Norma J. Sands</i>	
Hood Canal Summer-run Chum Salmon ESU	205
<i>By Norma J. Sands</i>	
Puget Sound/Strait of Georgia Coho Salmon ESU	215
<i>By Laurie A. Weitkamp</i>	
Lake Ozette Sockeye Salmon ESU	227
<i>By Norma J. Sands</i>	
Puget Sound Steelhead ESU	235
<i>By Jeffrey J. Hard</i>	
Climate Change	261
<i>By Michelle M. McClure</i>	
Known Climate-linked Effects on Anadromous Salmonid Populations	261
Projected Climate Changes in the Pacific Northwest	262
Likely Impacts on Anadromous Salmonid ESUs	264
References	267

List of Figures

Figure 1. ESUs for coho salmon proposed in 1995	10
Figure 2. Dendrogram using 53 polymorphic allozymes loci and based on pairwise genetic distance values between 101 samples of coho salmon from the Pacific Northwest	13
Figure 3. Multidimensional scaling and minimum spanning tree of pairwise chord distance values among 27 samples of coho salmon from lower Columbia River and southwest Washington coast.....	14
Figure 4. Dendrogram based on marine recovery patterns of 90 hatchery and 36 wild coho salmon populations.....	15
Figure 5. Neighbor-joining dendrogram generated from Cavalli-Sforza and Edwards' chord distances for 84 coho salmon samples collected within six regions of the Pacific coast	17
Figure 6. Current boundaries between the lower and middle Columbia River steelhead DPSs	20
Figure 7. UPGMA dendrogram of lower Columbia and Deschutes river steelhead based on CSE chord distances.....	21
Figure 8. Principal components analysis of allele frequency data for steelhead populations in the Columbia River basin	24
Figure 9. Dendrogram of lower Columbia River Chinook salmon populations	26
Figure 10. MDS of Cavalli-Sforza and Edwards chord distances based on 31 allozyme loci between 55 composite samples of Chinook salmon from populations in the Columbia River drainage	27
Figure 11. Proportion of sample assigned to three major Columbia River Chinook salmon lineages	27
Figure 12. Updated spawning abundance by year for upper Columbia River spring-run Chinook salmon populations	33
Figure 13. Trend of broodyear spawner-to-spawner return rate estimates for Upper Columbia River Spring-run Chinook Salmon ESU populations	34
Figure 14. Chiwawa River natural production SAR estimates, broodyear adult returns to the Wenatchee River divided by estimated smolts produced	36
Figure 15. Estimated number of natural-origin smolts produced from spawning in the Chiwawa River tributary within the Wenatchee River spring-run Chinook salmon population by year	37
Figure 16. North Cascades Spring-run Chinook Salmon MPG population risk ratings integrated across the four viable salmonid population metrics.....	39
Figure 17. Total exploitation rate by year for upper Columbia River spring-run Chinook salmon.....	39
Figure 18. Trends in hatchery releases by year within the spawning and rearing area of the Upper Columbia River Spring-run Chinook Salmon ESU	40
Figure 19. Annual spawning abundance by year for upper Columbia River steelhead populations	45
Figure 20. Return per spawner estimates by year for upper Columbia River steelhead populations	47

Figure 21. North Cascades MPG steelhead population risk ratings integrated across the four VSP metrics	50
Figure 22. Total exploitation rate by year on natural summer steelhead above Bonneville Dam	51
Figure 23. Trend in hatchery releases of upper Columbia River steelhead by year	51
Figure 24. Spawning abundance by year for the east Cascades MPG in the Middle Columbia River Steelhead DPS.....	55
Figure 25. Productivity of the east Cascades MPG in the Middle Columbia River Steelhead DPS.....	56
Figure 26. Spawning abundance by year for the John Day MPG in the Middle Columbia River Steelhead DPS.....	57
Figure 27. Productivity of the John Day MPG in the Middle Columbia River Steelhead DPS.....	58
Figure 28. Spawning abundance by year for the Yakima MPG in the Middle Columbia River Steelhead DPS.....	59
Figure 29. Productivity of the Yakima MPG in the Middle Columbia River Steelhead DPS	60
Figure 30. Spawning abundance by year for the Umatilla/Walla Walla MPG in the Middle Columbia River Steelhead DPS	60
Figure 31. Productivity of the Umatilla/Walla Walla MPG in the Middle Columbia River Steelhead DPS.....	61
Figure 32. Short-term trends in natural-origin spawners and short-term population growth rate estimates for mid-Columbia steelhead.....	64
Figure 33. Total exploitation rate on natural summer steelhead above Bonneville Dam by year	71
Figure 34. Summary of hatchery releases by year for species within the spawning and rearing boundaries of the Middle Columbia River Steelhead ESU.....	72
Figure 35. Spawning abundance by year for the Grande Ronde/Imnaha MPG in the Snake River Spring/Summer-run Chinook Salmon ESU	76
Figure 36. Spawning abundance by year for the Lower Snake MPG in the Snake River Spring/Summer-run Chinook Salmon ESU	77
Figure 37. Spawning abundance by year for the South Fork Salmon MPG in the Snake River Spring/Summer-run Chinook Salmon ESU	77
Figure 38. Spawning abundance by year for the Middle Fork Salmon River MPG in the Snake River Spring/Summer-run Chinook Salmon ESU	78
Figure 39. Spawning abundance by year for the Upper Salmon River MPG in the Snake River Spring/Summer-run Chinook Salmon ESU	79
Figure 40. Snake River Spring/Summer-run Chinook salmon	80
Figure 41. Short-term trend in natural-origin spawning abundance for Snake River Spring/Summer-run Chinook salmon populations	81
Figure 42. Short-term population growth rate estimates for Snake River Spring/Summer-run Chinook salmon populations	81
Figure 43. Short-term population growth rate estimates for Snake River Spring/Summer-run Chinook salmon populations	82
Figure 44. Total exploitation rates by year for Snake River spring/summer-run Chinook salmon	82

Figure 45. Trends in hatchery releases by year within the spawning and rearing areas of the Snake River Spring/Summer-run Chinook Salmon ESU	92
Figure 46. Estimated escapement by year for Snake River fall-run Chinook salmon above Lower Granite Dam.....	94
Figure 47. Snake River fall-run Chinook salmon broodyear spawner to spawner estimates.....	95
Figure 48. Snake River lower mainstem fall-run Chinook salmon population risk ratings integrated across the four VSP metrics.....	98
Figure 49. Exploitation rate by year for Snake River fall-run Chinook salmon	99
Figure 50. Snake River hatchery releases by year since 1980	100
Figure 51. Estimated proportion of fall presmolt plants outmigrating in the spring of the following year	106
Figure 52. Snake River sockeye salmon juvenile downstream survival estimates for 2008 migration year	106
Figure 53. Total exploitation rates by year on Snake River sockeye salmon	108
Figure 54. Annual hatchery releases by year within the spawning and rearing areas of the Snake River Sockeye Salmon ESU	109
Figure 55. Snake River steelhead population estimates by year. The dark line indicates natural-origin spawner numbers and the light line indicates total natural spawners.....	113
Figure 56. Lower Granite Dam counts for Snake River steelhead.....	117
Figure 57. Snake River steelhead index areas.....	118
Figure 58. Juvenile Snake River steelhead parr densities observed in IDFG snorkel transects.....	119
Figure 59. Total exploitation rate by year for natural summer steelhead above Bonneville Dam.....	123
Figure 60. Hatchery releases by year within the Snake River Steelhead DPS.....	124
Figure 61. Historical lower Columbia River fall and late fall-run Chinook salmon populations	127
Figure 62. Historical lower Columbia River spring-run Chinook salmon populations	128
Figure 63. Extinction risk ratings for lower Columbia River Chinook salmon populations in Oregon for the assessment attributes A/P, diversity, overall status, and spatial structure	129
Figure 64. Current status of Washington lower Columbia River fall-run Chinook salmon populations for the VSP parameters and overall population risk	130
Figure 65. Current status of Washington lower Columbia River spring Chinook and late fall-run Chinook salmon populations for the VSP parameters and overall population risk	131
Figure 66. Estimated spawning abundance by year for the coastal MPG.....	132
Figure 67. Estimated spawning abundance by year for the Cascade fall and spring-run MPG	133
Figure 68. Estimated spawning abundance by year for the Cascade fall and spring-run MPG	134
Figure 69. Estimated spawning abundance by year for the Gorge fall-run MPG	135
Figure 70. Total exploitation rates by year for the three components of the Lower Columbia River Chinook Salmon ESU	135

Figure 71. Total Chinook hatchery releases by year in the Lower Columbia River Chinook Salmon ESU.....	136
Figure 72. Upper Willamette spring-run Chinook salmon populations.....	139
Figure 73. Status evaluation for upper Willamette spring-run Chinook salmon populations.....	140
Figure 74. Clackamas River spring-run Chinook salmon abundance estimates by year	141
Figure 75. Willamette Falls total spring-run Chinook salmon count and the count of unmarked fish at Leaburg dam on the McKenzie.....	142
Figure 76. McKenzie River spring Chinook salmon abundance estimates.....	143
Figure 77. Natural-origin and total spawner abundance estimates by year for the McKenzie River based on the run reconstruction in ODFW 2010 FMEP report.....	144
Figure 78. Total exploitation rates by year on Willamette River spring-run Chinook salmon.....	144
Figure 79. Hatchery releases by year for Chinook, coho, and steelhead in the area of the Upper Willamette River Chinook Salmon ESU	146
Figure 80. Historical Columbia River chum salmon populations.....	147
Figure 81. Current status of Washington Columbia River chum salmon populations for the VSP parameters and overall population risk	148
Figure 82. Grays River chum salmon spawner time series.....	149
Figure 83. Lower Gorge chum salmon spawner time series.....	150
Figure 84. Chum salmon count by year at Bonneville Dam.....	151
Figure 85. Columbia River chum salmon hatchery releases by year.....	152
Figure 86. Historical populations of lower Columbia River coho salmon.....	154
Figure 87. Extinction risk ratings for lower Columbia River coho salmon populations in Oregon for the assessment attributes A/P, diversity, and spatial structure	155
Figure 88. Current status of Washington lower Columbia River coho salmon populations for the VSP parameters and overall population risk.....	156
Figure 89. Abundance of lower Columbia River coho salmon populations by year	157
Figure 90. Coho salmon spawner estimates for the Mill, Germany, and Abernathy population in 2006	162
Figure 91. Coho salmon smolt production estimates for Mill, Germany, and Abernathy creeks.....	162
Figure 92. Total exploitation rate by year on lower Columbia River natural coho salmon.....	164
Figure 93. Lower Columbia River hatchery releases by year for all salmon and steelhead species released within the spawning and rearing area of the Lower Columbia River Coho Salmon ESU	165
Figure 94. Populations of lower Columbia River winter steelhead and summer steelhead.....	168
Figure 95. Oregon lower Columbia River steelhead population status.....	169
Figure 96. Current status of Washington lower Columbia River steelhead populations for the VSP parameters and overall population risk	170
Figure 97. Lower Columbia River steelhead trends in abundance by year.....	171
Figure 98. Lower Columbia River steelhead trends in abundance by year.....	172

Figure 99. Total exploitation rates on natural winter steelhead from the Columbia Basin by year.....	173
Figure 100. Annual lower Columbia River steelhead hatchery releases by year.....	173
Figure 101. Upper Willamette River steelhead populations	175
Figure 102. Status of upper Willamette steelhead populations.....	176
Figure 103. Count of winter-run steelhead spawners by year at Willamette Falls	177
Figure 104. Spawner abundance of upper Willamette steelhead populations by year.....	178
Figure 105. Total exploitation rates (%) by year on natural winter-run steelhead from the Columbia Basin.....	179
Figure 106. Nonnative, summer-run steelhead count of spawners by year at Willamette Falls.....	179
Figure 107. Steelhead hatchery releases by year in the upper Willamette Basin.....	180
Figure 108. Total natural spawners by year for the Puget Sound Chinook Salmon ESU and the natural-origin spawners.....	184
Figure 109. Spawning abundance by year for the central/south MPG in the Puget Sound Chinook Salmon ESU.....	187
Figure 110. Spawning abundance by year for the northwest or Strait of Juan de Fuca MPG in the Puget Sound Chinook Salmon ESU.....	188
Figure 111. Spawning abundance by year for the central west or Hood Canal MPG in the Puget Sound Chinook Salmon ESU.....	188
Figure 112. Spawning abundance by year for the northeast or Strait of Georgia MPG in the Puget Sound Chinook Salmon ESU.....	189
Figure 113. Spawning abundance by year for the central east or Whidbey Basin MPG in the Puget Sound Chinook Salmon ESU.....	190
Figure 114. Spawning abundance by year for the central east or Whidbey Basin MPG in the Puget Sound Chinook Salmon ESU.....	191
Figure 115. Total natural-origin returns of Chinook salmon to Puget Sound in return years representing total return, terminal return, and natural-origin spawners to the spawning grounds.....	196
Figure 116. Observed returns relative to the estimated recovery spawner–recruit relationship for two populations in the Strait of Georgia region, the South Fork Nooksack and North Fork Nooksack...	196
Figure 117. Observed returns relative to the estimated recovery spawner–recruit relationship for 6 of the 10 populations in the Whidbey Basin region.....	197
Figure 118. Observed returns relative to the estimated recovery spawner–recruit relationship for 4 of the 10 populations in the Whidbey Basin region.....	198
Figure 119. Observed returns relative to the estimated recovery spawner–recruit relationship for six populations in the central/south sound region.....	199
Figure 120. Observed returns relative to the estimated recovery spawner–recruit relationship for two Chinook salmon populations in the Hood Canal region, the Skokomish and the mid Hood Canal...	200
Figure 121. Observed returns relative to the estimated recovery spawner–recruit relationship for two populations in the Strait of Juan de Fuca region, the Dungeness and the Elwha.....	200
Figure 122. Trends in Puget Sound salmon total exploitation rates by year for each major population group	202

Figure 123. Trends in Puget Sound Chinook salmon terminal harvest rates by year for each MPG.....	203
Figure 124. Puget Sound hatchery releases by year.....	204
Figure 125. Spawning abundance of summer-run chum salmon by year	208
Figure 126. Relative abundance for the natural spawning aggregations of the Strait of Juan de Fuca summer-run chum salmon population.....	212
Figure 127. Relative abundance for the natural spawning aggregations of the Hood Canal summer-run chum salmon population.....	213
Figure 128. Viability curves for the Hood Canal summer-run chum salmon population for no harvest and three levels of harvest using the equal to or less than 5% probability of extinction over 100 years..	214
Figure 129. Viability curves for the Strait of Juan de Fuca summer-run chum salmon population for no harvest and three levels of harvest	215
Figure 130. Total exploitation rate by year for summer-run chum salmon	216
Figure 131. Summary of total hatchery releases by year per species within the spawning and rearing areas of the Hood Canal Summer-run Chum Salmon ESU	217
Figure 132. Spawning escapement trends by year in the major wild population areas of Puget Sound coho salmon	220
Figure 133. Total exploitation rates by year on Puget Sound coho salmon stocks.....	222
Figure 134. Summary of hatchery releases by year within the Puget Sound/Strait of Georgia Coho Salmon ESU spawning and rearing areas	223
Figure 135. Percent of Puget Sound coho salmon of hatchery origin by year estimated for terminal run size and for spawners.....	224
Figure 136. Percent of marine survival rates by year for wild coho salmon populations in Puget Sound	224
Figure 137. Estimated smolt abundances by year for various Puget Sound coho salmon populations ...	225
Figure 138. Long-term trends in estimated weight of coho salmon by year caught in Washington commercial fisheries or Washington commercial troll fisheries.....	226
Figure 139. Trends of adult coho salmon size by return year from monitored wild populations in Puget Sound	227
Figure 140. Trends by year of adult size for salmon caught in in-river fisheries in north, central Puget Sound and Hood Canal, and the Strait of Juan de Fuca.....	228
Figure 141. Trend in spawning abundance of Lake Ozette sockeye salmon by year	233
Figure 142. Plot of the observations and total population estimate of Puget Sound winter-run steelhead for a putative Northern Cascades MPG by year.....	240
Figure 143. Plot of the observations and total population estimate of Puget Sound winter-run steelhead for a putative South Sound MPG by year	241
Figure 144. Plot of the observations and total population estimate of Puget Sound winter-run steelhead for a putative Olympic MPG by year	242
Figure 145. Population trends for Samish River winter-run steelhead	243
Figure 146. Population trends for Skagit River winter-run steelhead.....	244

Figure 147. Population trends for Stillaguamish River winter-run steelhead.....	245
Figure 148. Population trends for Snohomish River winter-run steelhead	246
Figure 149. Population trends for Lake Washington winter-run steelhead.....	247
Figure 150. Population trends for Green River winter-run steelhead	248
Figure 151. Population trends for Puyallup River winter-run steelhead.....	249
Figure 152. Population trends for Nisqually River winter-run steelhead	250
Figure 153. Population trends for White River winter-run steelhead	251
Figure 154. Population trends for Skokomish River winter-run steelhead	252
Figure 155. Population trends for east Hood Canal winter-run steelhead	253
Figure 156. Population trends for west Hood Canal winter-run steelhead	254
Figure 157. Population trends for Port Angeles winter-run steelhead.....	255
Figure 158. Population trends for Dungeness River winter-run steelhead	256
Figure 159. Population trends for Elwha River winter-run steelhead.....	257
Figure 160. Population trends for Tolt River summer-run steelhead.....	258
Figure 161. Summary of annual hatchery releases by year within the spawning and rearing areas of the Puget Sound Steelhead DPS.....	259
Figure 162. Total exploitation rates by year on natural steelhead from Puget Sound rivers	260

List of Tables

Table 1. List of viability reports completed by technical recovery teams	3
Table 2. Current listing status and summary of conclusions	4
Table 3. TRT reports on population structure within listed Pacific Northwest ESUs and distinct population segments.....	9
Table 4. Mean pairwise F_{st} values between regional groupings of Pacific Northwest coho salmon populations.....	17
Table 5. Ocean age frequency for selected steelhead populations.....	22
Table 6. Estimated spawning abundance in natural spawning areas for upper Columbia River spring-run Chinook salmon populations	32
Table 7. Short-term trend expressed as 5-year geometric means.....	35
Table 8. Short-term population growth rate estimates for upper Columbia River spring-run Chinook salmon populations	35
Table 9. Long-term trend metrics for upper Columbia River spring-run Chinook salmon populations....	35
Table 10. Viability assessments for upper Columbia River spring-run Chinook salmon populations in the North Cascades MPG.....	38
Table 11. Recent abundance and proportion natural origin in natural spawning areas compared to estimates at the time of listing and in the previous BRT review	44
Table 12. Comparison of current trends to prior reviews of short-term trend in natural-origin spawners, upper Columbia River spring-run Chinook salmon	46
Table 13. Current short-term population growth rate estimates versus 2005 BRT short-term time series	46
Table 14. Long-term trends in natural-origin spawning abundance for upper Columbia River steelhead populations	48
Table 15. Viability assessments for upper Columbia River steelhead populations, updated to reflect return years through 2009	49
Table 16. Summary of abundance and hatchery proportions in natural spawning areas for mid-Columbia steelhead populations organized by MPG.....	63
Table 17. Summary of current status of populations using viability criteria incorporated into the Mid-Columbia Steelhead Recovery Plan for the Cascades Eastern Slope MPG.....	65
Table 18. Summary of current status of populations using viability criteria incorporated into the Mid-Columbia Steelhead Recovery Plan for the John Day River MPG.....	66
Table 19. Summary of current status of populations using viability criteria incorporated into the Mid-Columbia Steelhead Recovery Plan for the Umatilla/Walla Walla MPG.....	67
Table 20. Summary of current status of populations using viability criteria incorporated into the Mid-Columbia Steelhead Recovery Plan for the Yakima MPG	68

Table 21. Recent estimates of total and natural-origin spawning escapement in natural spawning areas for Snake River spring/summer-run Chinook salmon populations, organized by MPG.....	69
Table 22. Summary of current population status versus ICTRT viability criteria for the Lower Snake River MPG.....	84
Table 23. Summary current population status versus ICTRT viability criteria for the Grande Ronde/Imnaha MPG	84
Table 24. Summary current population status versus ICTRT viability criteria for the South Fork Salmon River MPG.....	86
Table 25. Summary current population status versus ICTRT viability criteria for the Middle Fork Salmon River MPG.....	87
Table 26. Summary current population status versus ICTRT viability criteria for the Upper Salmon River MPG.....	89
Table 27. Recent abundance and proportion of natural origin Snake River fall-run Chinook salmon in natural spawning areas compared to estimates at the time of listing and the previous BRT review	95
Table 28. Short-term trends in natural-origin spawning abundance for the lower Snake River fall-run Chinook salmon population	95
Table 29. Short-term lambda trends in spawning abundance for the lower Snake River fall-run Chinook salmon population	96
Table 30. Long-term trend estimates for lower Snake River fall-run Chinook salmon population.....	96
Table 31. Viability assessments for lower Snake River fall-run Chinook salmon population using ICTRT criteria, updated to reflect return years through 2008.....	97
Table 32. Adult sockeye salmon returns to Stanley Basin weir sites.....	102
Table 33. Estimated annual numbers of salmon smolt outmigrants from the Stanley Basin.....	103
Table 34. Release of Snake River sockeye salmon progeny from the captive brood program.....	104
Table 35. Release of Snake River sockeye salmon progeny from the captive brood program.....	105
Table 36. Recent abundance and proportion natural origin in natural spawning areas compared to estimates at the time of listing and in the previous BRT review	113
Table 37. Short-term population growth rate estimates	114
Table 38. Short-term trend in total spawners for Snake River steelhead.....	114
Table 39. Long-term trends in spawning abundance for Snake River steelhead populations.....	114
Table 40. Recent abundance and proportion natural origin in natural spawning areas for aggregate returns to Lower Granite Dam	116
Table 41. Current status ratings using ICTRT viability criteria for Snake River steelhead populations grouped by MPG.....	121
Table 42. Population persistence categories	131
Table 43. Summary statistics for lower Columbia River coho salmon.....	158
Table 44. Lower Columbia River coho salmon escapement estimates for the 2002–2004 spawning seasons	159

Table 45. Mark rates based on observations of adipose fin clips on live and dead coho salmon spawners in random coho surveys during the 2002–2004 spawning seasons.....	160
Table 46. Lower Columbia River Coho Salmon ESU estimated abundance of adult coho spawning naturally by ESU, stratum, and population for the 2004–2008 run years.....	161
Table 47. Coho salmon smolt production from Cedar Creek	163
Table 48. Extant populations of Chinook salmon in the Puget Sound Chinook ESU	183
Table 49. The abundance trend.....	185
Table 50. Puget Sound Chinook average natural and natural-origin only spawners and percent hatchery contributions for 5-year intervals	186
Table 51. Short-term and long-term population trend and growth rate estimates for the Puget Sound Chinook Salmon ESU populations	192
Table 52. Productivity range and median for the populations for the 5-year ranges	194
Table 53. Puget Sound Chinook population average productivity for 5-year intervals measured as spawners per spawner	195
Table 54. Diversity and spatial structure of ESU, Shannon diversity index.....	196
Table 55. Broodyear AEQ ER ranges and medians for five 5-year intervals for ocean and terminal fisheries and total exploitation rate estimated for each of the 22 populations.....	200
Table 56. Puget Sound Chinook Population average AEQ ERs for 5-year intervals for both mixed-maturity catch fisheries and mature catch fisheries	201
Table 57. Current populations of summer-run chum salmon in the Hood Canal ESU and their associated historical spawning aggregations.....	206
Table 58. Five geometric means of all spawners and natural-origin spawners only for the two Hood Canal ESU summer-run chum salmon populations	208
Table 59. Short-term and long-term population trend and growth rate estimates for the Hood Canal Summer-run Chum Salmon ESU populations	209
Table 60. Five-year arithmetic mean of R/S for the populations and ESU.....	209
Table 61. Escapement, catch, and broodstock take data for the Stait of Juan de Fuca summer-run chum salmon population and the estimates of diversity, progeny recruits, and R/S.....	210
Table 62. Escapement, catch, and broodstock take data for the Hood Canal summer-run chum salmon population and the estimates of diversity, progeny recruits, and R/S	211
Table 63. Five-year Arithmetic Averages of Diversity Index for the two populations and trend measured over the 5-year averages	212
Table 64. Short-term and long-term trends for the major natural production stocks of Puget Sound coho salmon	221
Table 65. Marine survival rate information for wild Puget Sound coho salmon populations	224
Table 66. Smolt production estimates for Puget Sound populations	226
Table 67. Regression statistics for changes in adult size over time	229
Table 68. Natural spawning escapement, natural-origin fish, the percent of natural escapement that is hatchery origin, and the percent of natural spawners that occur in the tributaries	232

Table 69. Five-year geometric mean escapements for natural-origin spawners and natural spawners for Lake Ozette sockeye salmon and trend over the 5-year intervals	233
Table 70. Short-term and long-term population trend and growth rate estimates for the Lake Ozette sockeye salmon population	233
Table 71. R/S for Lake Ozette sockeye salmon broodyears 1977–2003 and 5-year arithmetic averages	234
Table 72. Hatchery releases into Umbrella Creek and Big Creek	235
Table 73. Estimates of exponential trend in the natural logarithm of natural spawners for several winter-run populations of steelhead in the Puget Sound DPS	237
Table 74. Geometric means of natural spawners for several winter-run populations of steelhead in the Puget Sound DPS over the most recent 5 years	237
Table 75. Summary of expected physical and chemical climate changes in the Pacific Northwest.....	263
Table 76. Summary of expected climate effects on Pacific Northwest ESUs	265

body size and morphology, and reproductive traits (i.e., egg size). Population genetic structure can be very informative for estimating the degree of reproductive isolation among populations. Similarly, mark/recapture studies provide information on the level of interpopulation migration, although straying does not necessarily result in successful introgression.

Habitat and ecological information has been extensively used to establish ESU and DPS boundaries, especially where there is little population specific information available. Given the high level of homing fidelity exhibited by salmonids and the associated degree of local adaptation in life history traits, habitat characteristics become a useful proxy for putative differences in life history traits. Similarly, biogeographic boundaries and the distribution and ESU structure of similar species have been used where information on the species in question is lacking.

In initially defining the structure of ESUs and DPSs, the BRTs analyzed a variety of different data types of varying quality. At the time, the BRTs recognized that ESU boundaries would not necessarily be discrete, rather a transitional zone covering one or more basins might exist at the interface between putative ESUs. In some cases, especially where there was not a geographic feature to rely on, there was some degree of uncertainty in the identification of ESU boundaries. Population-specific information was frequently limited and in some cases natural populations in the transitional zone had been extirpated or modified by the transfer of fish between basins. Ultimately, the BRTs have used the best available information to assign transitional populations into ESUs/DPSs with the understanding that, if additional information became available, the decisions regarding the boundaries could be revisited.

New Information

The majority of the ESUs and DPSs for Pacific salmon and steelhead were initially defined in the late 1990s as part of the coast-wide status review process undertaken by the NMFS. In the intervening 15 years, the most marked change in population monitoring has arguably been in the analysis of genetic variation. Initially, the majority of the genetics information was developed using starch-gel electrophoresis of allozymes. The utilization of DNA microsatellite technology in fisheries during the last 10 years has provided a wealth of additional genetic information. Overall, this technique has provided a finer level of discrimination than was possible with allozymes. Furthermore, since the initial listings there have been extensive monitoring efforts throughout the West Coast. Thus the quality and quantity of genetic information available to address the issue of ESU and DPS delineation has improved considerably.

For a number of populations, monitoring efforts over the last 15 years have expanded the existing databases on abundance, spawn timing, and migratory patterns. Additionally, the mass marking of hatchery-origin juveniles has improved the quality of the data collected, especially regarding the life history data of naturally produced fish.

Information of all types, from published and unpublished sources, was reviewed in order to assess whether sufficient data existed to justify a reconsideration of the ESU boundary. Much of the relevant information had already been summarized by the TRTs in their identification of populations within listed ESUs and DPSs (Table 3). This review will not explicitly discuss all of

Table 3. TRT reports on population structure within listed Pacific Northwest ESUs and distinct population segments. See <http://www.nwfsc.noaa.gov/trt/pubs.cfm> for copies of these reports.

Domain	Population structure document name	Year completed
Puget Sound Chinook	Independent populations of Chinook salmon in Puget Sound	2006
Puget Sound, Hood canal summer chum	Determination of independent populations and viability criteria for the Hood Canal summer chum salmon ESU	2009
Puget Sound, Lake Ozette sockeye	Identification of an independent population of sockeye salmon in Lake Ozette, Washington	2009
Willamette and Lower Columbia	Historical population structure of Pacific salmonids in the Willamette River and lower Columbia River basins	2006
Oregon coast	Identification of historical populations of coho salmon in the Oregon coast ESU	2007
Interior Columbia basin	Independent populations of Chinook, steelhead, and sockeye for listed ESUs within the interior Columbia River domain	2003

the information that was considered, but rather focuses on information pertaining to ESUs and DPSs that would potentially justify further investigation regarding changes in boundaries.

Coho Salmon—Puget Sound and Washington Coast ESUs

ESUs for West Coast coho salmon were originally delineated in 1995 (Weitkamp et al. 1995). At that time, six ESUs were identified: 1) central California coast, 2) northern California/southern Oregon coasts, 3) Oregon coast, 4) Columbia River/southwest Washington, 5) Olympic Peninsula, and 6) Puget Sound/Strait of Georgia (Figure 1). In 2005 NMFS determined that the Columbia River/Southwest Washington ESU should be split and the Columbia River portion was listed under the ESA, leaving the status of southwest Washington coho salmon populations in question.

Since the original status review, new genetic and life history information has become available that provides further insight into how coho salmon are likely adapted to habitats throughout their range, resulting in reproductive isolation and phenotypic variation. This new information has yet to be considered for those coho salmon ESUs, which have not been evaluated since the original status review. Accordingly, this analysis will focus on coho salmon populations that occupy freshwater habitats along the Washington coast, Strait of Juan de Fuca, Puget Sound, and southern British Columbia. Possible changes to ESU boundaries have previously been considered for coho salmon from northern California and Oregon and were found to be consistent with the best scientific information (Stout et al. in press) and therefore will not be discussed here.



2016 5-Year Review:
Summary & Evaluation of
**Lower Columbia River Chinook
Salmon**
Columbia River Chum Salmon
Lower Columbia River Coho Salmon
Lower Columbia River Steelhead

National Marine Fisheries Service
West Coast Region
Portland, OR



This page intentionally left blank

5-Year Review: Lower Columbia River Species

Species Reviewed	Evolutionarily Significant Unit or Distinct Population Segment
Chinook Salmon <i>(Oncorhynchus tshawytscha)</i>	<i>Lower Columbia River Chinook Salmon</i>
Chum Salmon <i>(O. keta)</i>	<i>Columbia River Chum Salmon</i>
Coho Salmon <i>(O. kisutch)</i>	<i>Lower Columbia River Coho Salmon</i>
Steelhead <i>(O. mykiss)</i>	<i>Lower Columbia River Steelhead</i>

This page intentionally left blank

Table of Contents

1 • GENERAL INFORMATION	1
1.1 Introduction	1
1.1.1 Background on listing determinations	1
1.2 Methodology used to complete the review	2
1.3 Background – Summary of Previous Reviews, Statutory and Regulatory Actions, and Recovery Planning	3
1.3.1 Federal Register Notice announcing initiation of this review	3
1.3.2 Listing history	3
1.3.3 Associated rulemakings	4
1.3.4 Review History	5
1.3.5 Species’ Recovery Priority Number at Start of 5-year Review Process	7
1.3.6 Recovery Plan or Outline	8
2 • REVIEW ANALYSIS.....	11
2.1 Delineation of species under the Endangered Species Act	11
2.1.1 Summary of relevant new information regarding the delineation of the lower Columbia River ESUs/DPS	12
ESU/DPS Composition	12
Membership of Hatchery Programs	12
2.2 Recovery Criteria.....	13
2.2.1 Do the species have a final, approved recovery plan containing objective, measurable criteria?	13
2.2.2 Adequacy of recovery criteria	13
2.2.3 List the biological recovery criteria as they appear in the recovery plan	14
LCR Chinook Salmon.....	14
CR Chum Salmon	15
LCR Coho Salmon	15
LCR Steelhead.....	18
2.3 Updated Information and Current Species’ Status	18
2.3.1 Analysis of Viable Salmonid Population (VSP) Status	21
LCR Chinook Salmon.....	21
CR Chum Salmon	22
LCR Coho Salmon	22
LCR Steelhead.....	23
2.3.2 Five-Factor Analysis	24
Listing Factor A: Present or threatened destruction, modification or curtailment of its habitat or range.....	24
Listing Factor B: Overutilization for commercial, recreational, scientific, or educational purposes	29
Listing Factor C: Disease or Predation.....	32
Listing Factor D: Adequacy & Inadequacy of Regulatory Mechanisms and Protective Efforts	36
Listing Factor E: Other natural or manmade factors affecting its continued existence.....	46
Efforts being made to Protect the Species.....	53
2.4 Synthesis.....	54
2.4.1 ESU/DPS Delineation and Hatchery Membership.....	56

2.4.2 ESU/DPS Viability and Statutory Listing Factors	56
3 • RESULTS.....	58
3.1 Classification	58
Listing status:	58
ESU/DPS delineation:.....	58
Hatchery membership:	58
3.2 New Recovery Priority Number.....	59
4 • RECOMMENDATIONS FOR FUTURE ACTIONS	61
5 • REFERENCES.....	64
5.1 Federal Register Notices	64
5.2 Literature Cited	65

1 · General Information

1.1 Introduction

Many West Coast salmon and steelhead (*Oncorhynchus* sp.) stocks have declined substantially from their historic numbers and now are at a fraction of their historical abundance. There are several factors that contribute to these declines, including: overfishing, loss of freshwater and estuarine habitat, hydropower development, poor ocean conditions, and hatchery practices. These factors collectively led to the National Marine Fisheries Service's (NMFS) listing of 28 salmon and steelhead stocks in California, Idaho, Oregon, and Washington under the Federal Endangered Species Act (ESA).

The ESA, under section 4(c)(2), directs the Secretary of Commerce to review the listing classification of threatened and endangered species at least once every five years. After completing this review, the Secretary must determine if any species should be: (1) removed from the list; (2) have its status changed from threatened to endangered; or (3) have its status changed from endangered to threatened. The most recent listing determinations for most salmon and steelhead occurred in 2005 and 2006. This document describes the results of the agency's five-year status review for ESA-listed lower Columbia River salmon and steelhead species. These include: Lower Columbia River Chinook salmon, Columbia River chum salmon, Lower Columbia River coho salmon, and Lower Columbia River steelhead.

1.1.1 Background on listing determinations

The ESA defines species to include subspecies and distinct population segments (DPS) of vertebrate species. A species may be listed as threatened or endangered. To identify distinct population segments of salmon species we apply the "Policy on Applying the Definition of Species under the ESA to Pacific Salmon" (56 FR 58612). Under this policy we identify population groups that are "evolutionarily significant units" (ESU) within their species. We consider a group of populations to be an ESU if it is substantially reproductively isolated from other populations, and represents an important component in the evolutionary legacy of the biological species. We consider an ESU as constituting a DPS and therefore a "species" under the ESA.

To identify DPSs of steelhead, we apply the joint U.S. Fish and Wildlife Service-National Marine Fisheries Service DPS policy (61 FR 4722) rather than the ESU policy. Under this policy, a DPS of steelhead must be discrete from other populations, and it must be significant to its taxon.

Artificial propagation programs (hatcheries) are common throughout the range of ESA-listed West Coast salmon and steelhead. Prior to 2005, our policy was to include in the listed ESU or DPS only those hatchery fish deemed "essential for conservation" of the species. We revised that approach in response to a court decision and on June 28, 2005, announced a final policy

addressing the role of artificially propagated Pacific salmon and steelhead in listing determinations under the ESA (70 FR 37204) (hatchery listing policy). This policy establishes criteria for including hatchery stocks in ESUs and DPSs. In addition, it (1) provides direction for considering hatchery fish in extinction risk assessments of ESUs and DPSs; (2) requires that hatchery fish determined to be part of an ESU or DPS be included in any listing of the ESU or DPS; (3) affirms our commitment to conserving natural salmon and steelhead populations and the ecosystems upon which they depend; and (4) affirms our commitment to fulfilling trust and treaty obligations with regard to the harvest of some Pacific salmon and steelhead populations, consistent with the conservation and recovery of listed salmon ESUs and steelhead DPSs.

To determine whether a hatchery program is part of an ESU or DPS, and therefore must be included in the listing, we consider the origins of the hatchery stock, where the hatchery fish are released, and the extent to which the hatchery stock has diverged genetically from the donor stock. We include within the ESU or DPS (and therefore within the listing) hatchery fish that are no more than moderately diverged from the local population.

Because the new hatchery listing policy changed the way we considered hatchery fish in ESA listing determinations, we completed new status reviews and ESA listing determinations for West Coast salmon ESUs on June 28, 2005 (70 FR 37160), and for steelhead DPSs on January 5, 2006 (71 FR 834). On August 15, 2011, we published our status reviews and listing determinations for 11 ESUs of Pacific salmon and 6 DPSs of steelhead from the Pacific Northwest (76 FR 50448).

1.2 Methodology used to complete the review

On February 6, 2015, we announced the initiation of five year reviews for 17 ESUs of salmon and 11 DPSs of steelhead in Oregon, California, Idaho, and Washington (80 FR 6695). We requested that the public submit new information on these species that has become available since our original listing determinations or since the species' status was last updated. In response to our request, we received information from Federal and state agencies, Native American Tribes, conservation groups, fishing groups, and individuals. We considered this information, as well as information routinely collected by our agency, to complete these five year reviews.

To complete the reviews, we first asked scientists from our Northwest and Southwest Centers to collect and analyze new information about ESU and DPS viability. To evaluate viability, our scientists used the Viable Salmonid Population (VSP) concept developed by McElhany et al. (2000). The VSP concept evaluates four criteria – abundance, productivity, spatial structure, and diversity – to assess species viability. Through the application of this concept, the science center considered new information for a given ESU or DPS relative to the four salmon and steelhead population viability criteria. They also considered new information on ESU and DPS composition. At the end of this process, the science team prepared reports detailing the results of their analyses (NWFSC 2015).

To further inform the reviews, we also asked salmon management biologists from our West Coast Region familiar with hatchery programs to consider new information available since the previous listing determinations. Among other things, they considered whether any hatchery programs have ended or new hatchery programs have started, any changes in the operation of existing programs, and scientific data relevant to the degree of divergence of hatchery fish from naturally spawning fish in the same area. They produced a report (Jones 2015) describing their findings. Finally, we consulted salmon management biologists from the West Coast Region who are familiar with hatchery programs, habitat conditions, hydropower operations, and harvest management. In a series of structured meetings, by geographic area, these biologists identified relevant information and provided their insights on the degree to which circumstances have changed for each listed entity.

In preparing this report, we considered the best available scientific information, including the work of the Northwest Fisheries Science Center (NWFSC 2015); the report of the regional biologists regarding hatchery programs (Jones 2015); recovery plans for the species in question; technical reports prepared in support of recovery plans for the species in question; the listing record (including designation of critical habitat and adoption of protective regulations); recent biological opinions issued for lower Columbia River salmon and steelhead; information submitted by the public and other government agencies; and the information and views provided by the geographically based management teams. The present report describes the agency's findings based on all of the information considered.

1.3 Background – Summary of Previous Reviews, Statutory and Regulatory Actions, and Recovery Planning

1.3.1 Federal Register Notice announcing initiation of this review

80 FR 6695; February 6, 2015

1.3.2 Listing history

Beginning in 1998, NMFS began listing salmonid species in the lower Columbia River under the ESA. Over the next several years, four species of salmonids in this area were listed as threatened (Table 1).

Table 1. Summary of the listing history under the Endangered Species Act for ESUs and DPS in the lower Columbia River.

Salmonid Species	ESU/DPS Name	Original Listing	Revised Listing(s)
Chinook Salmon (<i>O. tshawytscha</i>)	Lower Columbia River Chinook Salmon	FR Notice: 64 FR 14308 Date: 3/24/1999 Classification: Threatened	FR Notice: 70 FR 37160 Date: 6/28/2005 Re-classification: Threatened

Salmonid Species	ESU/DPS Name	Original Listing	Revised Listing(s)
Chum Salmon (<i>O. keta</i>)	Columbia River Chum Salmon	FR Notice: 64 FR 14508 Date: 3/25/1999 Classification: Threatened	FR Notice: 70 FR 37160 Date: 6/28/2005 Re-classification: Threatened
Coho Salmon (<i>O. kisutch</i>)	Lower Columbia River Coho Salmon	FR Notice: 70 FR 37160 Date: 6/28/2005 Classification: Threatened	NA
Steelhead (<i>O. mykiss</i>)	Lower Columbia River Steelhead	FR Notice: 63 FR 13347 Date: 3/19/1998 Classification: Threatened	FR Notice: 71 FR 834 Date: 1/5/2006 Re-classification: Threatened

1.3.3 Associated rulemakings

The ESA requires NMFS to designate critical habitat, to the maximum extent prudent and determinable, for species it lists under the ESA. Critical habitat is defined as: (1) specific areas within the geographical area occupied by the species at the time of listing, if they contain physical or biological features essential to conservation, and those features may require special management considerations or protection; and (2) specific areas outside the geographical area occupied by the species at the time of listing if the agency determines that the area itself is essential for conservation. We designated critical habitat for Lower Columbia River (LCR) Chinook salmon, Columbia River (CR) chum salmon, and LCR steelhead in 2005, and we designated critical habitat for LCR coho salmon in 2016 (Table 2). Section 9 of the ESA prohibits the take of species listed as endangered. The ESA defines take to mean harass, harm, pursue, hunt, shoot, wound, trap, capture, or collect, or attempt to engage in any such conduct. For threatened species, the ESA does not automatically prohibit take, but instead authorizes the agency to adopt regulations it deems necessary and advisable for species conservation including regulations that prohibit take (ESA section 4(d)). In 2000, NMFS adopted 4(d) regulations for threatened salmonids that prohibit take except in specific circumstances. In 2005, we revised our 4(d) regulations for consistency between ESUs and DPSs, and, to take into account our hatchery listing policy.

Table 2. Summary of rulemaking for 4(d) protective regulations and critical habitat for ESUs and DPS in the lower Columbia River.

Salmonid Species	ESU Name	4(d) Protective Regulations	Critical Habitat Designations
Chinook Salmon (<i>O. tshawytscha</i>)	Lower Columbia River Chinook Salmon	FR notice: 65 FR 42422 Date: 7/10/2000 Revised: 6/28/2005 (70 FR 37160)	FR Notice: 70 FR 52630 Date: 9/2/2005
Chum Salmon (<i>O. keta</i>)	Columbia River Chum Salmon	FR notice: 65 FR 42422 Date: 7/10/2000 Revised: 6/28/2005 (70 FR 37160)	FR Notice: 70 FR 52630 Date: 9/2/2005
Coho Salmon (<i>O. kisutch</i>)	Lower Columbia River Coho Salmon	FR Notice: 70 FR 37160 Date: 6/28/2005	FR Notice: 81 FR 9252 Date: 2/24/2016
Steelhead (<i>O. mykiss</i>)	Lower Columbia River Steelhead	FR notice: 65 FR 42422 Date: 7/10/2000 Revised: 6/28/2005 (70 FR 37160)	FR notice: 70 FR 52630 Date: 9/2/2005

1.3.4 Review History

Table 3 lists the numerous scientific assessments of the status of lower Columbia River salmon ESUs and steelhead DPS. These assessments include status reviews conducted by our Northwest Fisheries Science Center and technical reports prepared in support of recovery planning for this species.

See discussions, stats, and author profiles for this publication at: <https://www.researchgate.net/publication/240765607>

Steelhead Life History on California's Central Coast: Insights from a State-Dependent Model

Article in *Transactions of the American Fisheries Society* · May 2009

DOI: 10.1577/T08-164.1

CITATIONS

74

READS

333

8 authors, including:



William Hallowell Satterthwaite

National Oceanic and Atmospheric Administration

94 PUBLICATIONS 1,019 CITATIONS

[SEE PROFILE](#)



Michael Beakes

Cramer Fish Sciences

16 PUBLICATIONS 295 CITATIONS

[SEE PROFILE](#)



David R. Swank

National Oceanic and Atmospheric Administration

6 PUBLICATIONS 195 CITATIONS

[SEE PROFILE](#)



Joseph E. Merz

University of California, Santa Cruz

84 PUBLICATIONS 1,589 CITATIONS

[SEE PROFILE](#)

Some of the authors of this publication are also working on these related projects:



Sturgeon Fin Rays: Effects of Collection and Uses [View project](#)



Forage fish [View project](#)

Steelhead Life History on California's Central Coast: Insights from a State-Dependent Model

WILLIAM H. SATTERTHWAITE*

*Center for Stock Assessment Research, Department of Applied Mathematics and Statistics,
University of California Santa Cruz, Santa Cruz, California 95064, USA*

MICHAEL P. BEAKES

*Center for Stock Assessment Research, Department of Applied Mathematics and Statistics, University of
California Santa Cruz, Santa Cruz, California 95064, USA; and National Marine Fisheries Service,
110 Shaffer Road, Santa Cruz, California 95060, USA*

ERIN M. COLLINS

California Department of Fish and Game, 8175 Alpine Avenue, Suite F, Sacramento, California 95826, USA

DAVID R. SWANK

*Center for Stock Assessment Research, Department of Applied Mathematics and Statistics, University of
California Santa Cruz, Santa Cruz, California 95064, USA; and National Marine Fisheries Service,
110 Shaffer Road, Santa Cruz, California 95060, USA*

JOSEPH E. MERZ

*Cramer Fish Sciences, 126 East Street, Auburn, California 95603, USA; and Institute of Marine Sciences,
University of California Santa Cruz, Santa Cruz, California 95064, USA*

ROBERT G. TITUS

California Department of Fish and Game, 8175 Alpine Avenue, Suite F, Sacramento, California 95826, USA

SUSAN M. SOGARD

National Marine Fisheries Service, 110 Shaffer Road, Santa Cruz, California 95060, USA

MARC MANGEL

*Center for Stock Assessment Research, Department of Applied Mathematics and Statistics,
University of California Santa Cruz, Santa Cruz, California 95064, USA*

(b)(4) copyright

(b)(4) copyright

* Corresponding author: satterth@darwin.ucsc.edu

Received August 8, 2008; accepted December 21, 2008
Published online May 4, 2009

(b)(4) copyright



(b)(4) copyright



(b)(4) copyright



(b)(4) copyright



(b)(4) copyright



(b)(4) copyright



(b)(4) copyright



(b)(4) copyright



(b)(4) copyright



(b)(4) copyright



(b)(4) copyright



(b)(4) copyright



(b)(4) copyright



(b)(4) copyright



(b)(4) copyright



(b)(4) copyright





U.S. Fish & Wildlife Service

ECOS[ECOS](#) / Species Profile

Bull Trout (*Salvelinus confluentus*)

[Range Information](#) | [Candidate Info](#) | [Federal Register](#) | [Recovery](#)
[Critical Habitat](#) | [SSA](#) | [Conservation Plans](#) | [Petitions](#) | [Biological](#)
[Opinions](#) | [Life History](#)

Taxonomy: [View taxonomy in ITIS](#)

**Listing Status: Threatened and Experimental
Population, Non-Essential**



General Information

Bull trout (*Salvelinus confluentus*) are members of the family Salmonidae and are char native Washington, Oregon, Idaho, Nevada, Montana and western Canada. Compared to other salmonids, bull trout have more specific habitat requirements that appear to influence their distribution and abundance. They need cold water to survive, so they are seldom found in waters where temperatures exceed 59 to 64 degrees (F). They also require stable stream channels, clean spawning and rearing gravel, complex and diverse cover, and unblocked migratory corridors. Bull trout may be distinguished from brook trout (*Salvelinus fontinalis*) by several characteristics: spots never appear on the dorsal (back) fin, and the spots that rest on the fish's olive green to bronze back are pale yellow, orange or salmon-colored. The bull trout's tail is not deeply forked as is the case with lake trout (*Salvelinus namaycush*). Bull trout exhibit two forms: resident and migratory. Resident bull trout spend their entire lives in the same stream/creek. Migratory bull trout move to larger bodies of water to overwinter and then migrate back to smaller waters to reproduce. An anadromous form of bull trout also exists in the Coastal-Puget Sound population, which spawns in rivers and streams but rears young in the ocean. Resident and juvenile bull trout prey on invertebrates and small fish. Adult migratory bull trout primarily eat fish. Resident bull trout range up to 10 inches long and migratory forms may range up to 35 inches and up to 32 pounds. Bull trout are currently listed coterminously as a threatened species.

The species historical range included Alaska, California, Idaho, Montana, Nevada, Oregon, Washington. See below for information about where the species is known or believed to occur.

Population detail

The following populations are being monitored: Bull Trout

Current Listing Status Summary

Show entries

Status	Date Listed	Lead Region	Where Listed
Threatened	06-10-1998	Pacific Region (Region 1)	U.S.A., conterminous, (lower 48 states) Addition
Experimental Population, Non-Essential	12-09-2009	Pacific Region (Region 1)	Clackamas River subbasin and the mainstem points of confluence with the Columbia River, i

Showing 1 to 2 of 2 entries

[< Previous](#)
[1](#)
[Next >](#)

» Range Information

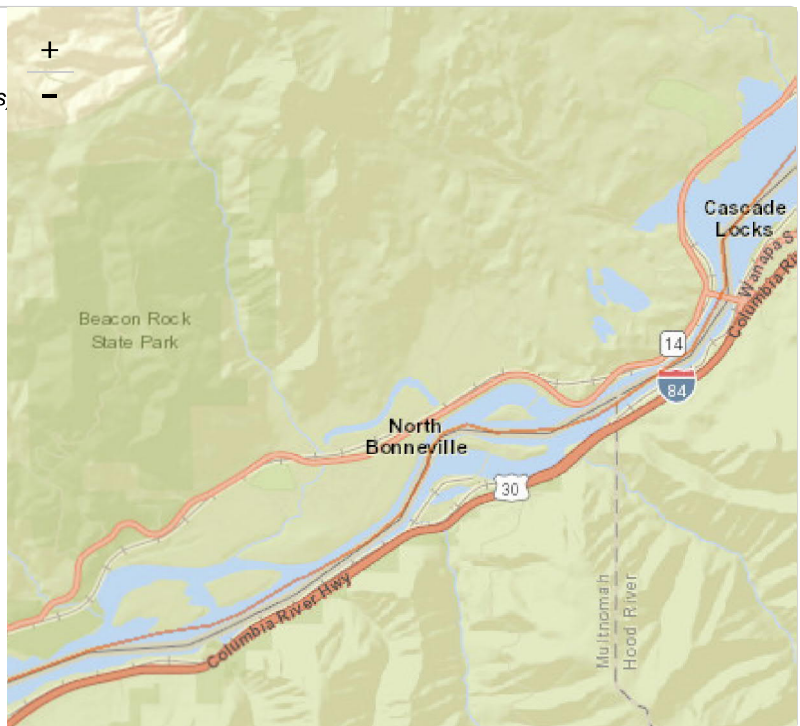
Current Range

☒   U.S.A., conterminous, (lower 48 states)

Zoom in! Some species' locations may be small and hard to see from a wide perspective. To narrow-in on locations, check the state and county lists (below) and then use the zoom tool.

Want the FWS's current range for all species? Click [here](#) to download a zip file containing all individual shapefiles and metadata for all species.

* For consultation needs do not use only this current range map, please use [IPaC](#).



- **U.S.A., conterminous, (lower 48 states)**

Listing status: Threatened

- **States/US Territories** in which this population is known to or is believed to occur: Idaho, Montana, Nevada, Oregon, Washington
- **US Counties** in which this population is known to or is believed to occur: [View All](#)
- **USFWS Refuges** in which this population is known to occur: Benton Lake Wetland Management District, Grays Harbor National Wildlife Refuge, Julia Butler Hansen Refuge for the Columbian White-Tailed Deer ...[Show All Refuges](#)

- **Clackamas River subbasin and the mainstem Willamette River, from Willamette Falls to its points of confluence with the Columbia River, including Multnomah Channel**

Listing status: Experimental Population, Non-Essential

- **States/US Territories** in which this population is known to or is believed to occur:
- **US Counties** in which this population is known to or is believed to occur: [View All](#)

- **USFWS Refuges** in which this population is known to occur: Northwest Montana Wetland Management District-Flathead County

» Candidate Information

No Candidate information available for this species.

No Candidate Assessments available for this species.

Candidate Notice of Review Documents

Show entries

Date ▼	Citation Page ◆	Title
10/30/2001	66 FR 54808 54832	<u>ETWP; Review of Plant and Animal Species That Are Candidates Threatened, Annual Notice of Findings on Recycled Petitions, and Actions; Proposed Rule</u>
10/25/1999	64 FR 57535 57547	<u>Review of Plant and Animal Taxa That Are Candidates or Propose Annual Notice of Findings on Recycled Petitions; Annual Descripti</u>
09/19/1997	62 FR 49398 49397	<u>Review of Plant and Animal Taxa</u>
02/28/1996	61 FR 7597 7613	<u>ETWP; Review of Plant and Animal Taxa That Are Candidates for</u>
11/15/1994	59 FR 58982 59028	<u>ETWP; Animal Candidate Review for Listing as Endangered or Th</u>
11/21/1991	56 FR 58804 58836	<u>ETWP; Animal Candidate Review for Listing as Endangered or Th</u>
01/06/1989	54 FR 554 579	<u>ETWP; Animal Notice of Review; 54 FR 554 579</u>

Showing 1 to 8 of 8 entries

< Previous 1 Next >

No Uplisting Documents currently available for this species.

» Federal Register Documents

Federal Register Documents

Show entries

Date ▼	Citation Page ◆	Title
07/24/2017	82 FR 34326 34329	<u>Notice of Intent To Prepare a Draft Environmental Impact Statement for the Basin Habitat Conservation Plan in Oregon</u>

09/30/2015	80 FR 58767 58768	Recovery Plan for the Coterminous United States Population of Bull Trout;
06/04/2015	80 FR 31916 31918	Endangered and Threatened Wildlife and Plants; Revised Draft Recovery Plan for the United States Population of Bull Trout and Draft Recovery Unit Implementation
09/04/2014	79 FR 52741 52743	ETWP; Revised Draft Recovery Plan for the Coterminous United States Population of Bull Trout (<i>Salvelinus confluentus</i>)
03/06/2012	77 FR 13248 13251	5-Year Status Reviews of 46 Species in Idaho, Oregon, Washington, Nevada, and the Northern Mariana Islands: Notice of initiation of reviews; request for comments

Showing 1 to 10 of 59 entries

[< Previous](#)
[1](#)
[2](#)
[3](#)
[4](#)
[5](#)
[6](#)
[Next >](#)

» Species Status Assessments (SSAs)

Species Status Assessments (SSAs)

No Species Status Assessments (SSA's) are currently available for this species.

Special Rule Publications

Show entries

Date ▼	Citation Page ◆	Title
06/21/2011	76 FR 35979 35995	Establishment of a Nonessential Experimental Population of Bull Trout
04/08/1999	64 FR 17110 17125	ETWP; Determination of Threatened Status for the Jarbidge River
06/10/1998	63 FR 31647 31674	ETWP; Determination of Threatened status for the Klamath River; of Bull Trout

Showing 1 to 3 of 3 entries

[< Previous](#)
[1](#)
[Next >](#)

» Recovery

- [Species with Recovery Documents Data Explorer](#)

Current Recovery Plan(s)

Show entries

Date	Plan Stage	Recovery Plan	Implementation Status
09/30/2015	Final	St. Mary Recovery Unit Implementation Plan for Bull Trout (<i>Salvelinus confluentus</i>)	View Implementation Progress
09/30/2015	Final	Coastal Recovery Unit Implementation Plan for Bull Trout (<i>Salvelinus confluentus</i>)	View Implementation Progress
09/30/2015	Final	Upper Snake Recovery Unit Implementation Plan for Bull Trout (<i>Salvelinus confluentus</i>)	View Implementation Progress
09/30/2015	Final	Coastal Recovery Unit Implementation Plan for Bull Trout (<i>Salvelinus confluentus</i>)	View Implementation Progress
09/30/2015	Final	Klamath Recovery Unit Implementation Plan for Bull Trout (<i>Salvelinus confluentus</i>)	View Implementation Progress
09/30/2015	Final	Columbia Headwaters Recovery Unit Implementation Plan for Bull Trout (<i>Salvelinus confluentus</i>)	View Implementation Progress

Showing 1 to 8 of 8 entries

[< Previous](#)
[1](#)
[Next >](#)

Other Recovery Documents

Show entries

Date	Citation Page	Title
09/30/2015	80 FR 58767 58768	Recovery Plan for the Coterminous United States Population of Bull Trout (<i>Salvelinus confluentus</i>) Availability
06/04/2015	80 FR 31916 31918	Endangered and Threatened Wildlife and Plants; Revised Draft Recovery Plan for the Coterminous United States Population of Bull Trout and Draft Recovery Implementation Plans
09/04/2014	79 FR 52741 52743	ETWP; Revised Draft Recovery Plan for the Coterminous United States Population of Bull Trout (<i>Salvelinus confluentus</i>)

03/06/2012	77 FR 13248 13251	5-Year Status Reviews of 46 Species in Idaho, Oregon, Washington, Hawaii, Guam, and the Northern Mariana Islands: Notice of initiation for information.
07/01/2004	69 FR 39951 39952	Draft Recovery Plan for the Jarbidge River Distinct Population Segment (Salvelinus confluentus)

Showing 1 to 8 of 8 entries

Five Year Reviews

Show

10

 entries

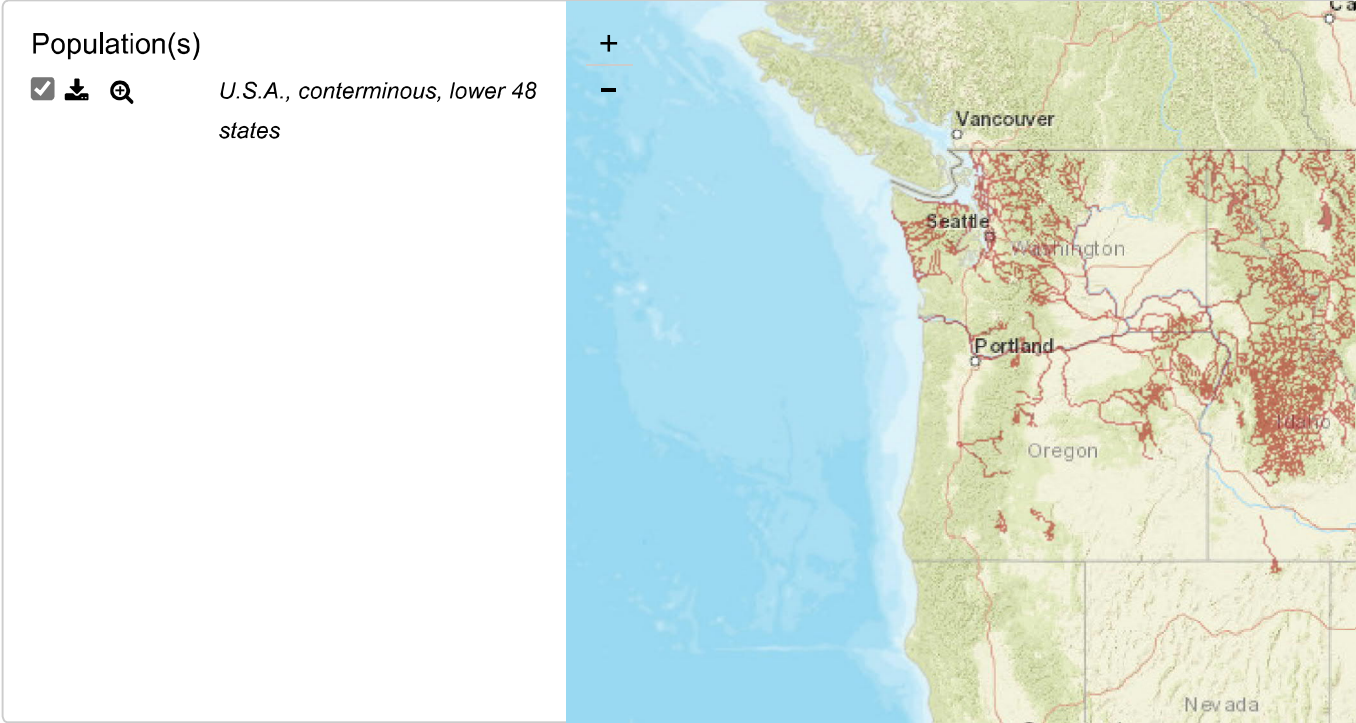
Date	Title
11/13/2015	2015 Bull Trout 5-year Review
04/25/2008	Bull Trout Completed 5-yr Review

Showing 1 to 2 of 2 entries

No Delisting Documents currently available for this species.

» Critical Habitat

Critical Habitat Spatial Extents



Critical Habitat DocumentsShow entries

Date	Citation Page	Title
10/18/2010	75 FR 63898 64070	<u>Revised Designation of Critical Habitat for Bull Trout in the Coterm</u> Rule

Showing 1 to 1 of 1 entries

< Previous 1 Next >

To learn more about critical habitat please see <http://ecos.fws.gov/crithab>**» Conservation Plans****Habitat Conservation Plans (HCP) ([learn more](#))**Show entries**HCP Plan Summaries**West Fork Timber HCP, Amendment (Addition of Bull Trout and Lynx)WDNR Forest Practices HCPWDNR Forest Lands HCP, Amendment (Bull Trout Addition)Washington Department of Natural Resources (WDNR) Low-effect HCP for Commercial Geoduck FishStoredahl's Daybreak Mine Expansion and Habitat Enhancement Project HCPStimson Lumber CompanySimpson Timber NW Operations (Green Diamond Resource Company)Plum Creek Timber I-90 HCP, Amendment (Bull Trout Addition)Plum Creek Timber I-90 HCP, Amendment (addition of Canada lynx and Puget Sound/Coastal DPS of I

Showing 1 to 10 of 16 entries

< Previous 1 2 Next >

Candidate Conservation Agreements (CCA): ([learn more](#))Show entries**CCA Plan Summaries**Conservation Agreement for bull trout in the South Fork of the Flathead River (Montana)

Showing 1 to 1 of 1 entries

< Previous 1 Next >

» Petitions

Show 10 ▼ entries

Petition Title	Date Received by the FWS	Where the species is believed to or known to occur	Petitioner Name	Requested Action	Pe Fir
Bull trout (<i>Salvelinus confluentus</i>)-Klamath R. & Columbia R. pops (Remanded finding)	11/03/1992	ID, MT, NV, OR, WA, United States		• Listing: Threatened	
Bull trout (<i>Salvelinus confluentus</i>)- Coastal/Puget Sound, Jarbridge River, & Saskatchewan pops (Remanded finding)	11/03/1992	ID, MT, NV, OR, WA, United States		• Listing: Threatened	
Bull trout (<i>Salvelinus confluentus</i>)- Coastal/Puget Sound, Jarbridge River, & Saskatchewan pops (Remanded finding)	11/03/1992	ID, MT, NV, OR, WA, United States		• Listing: Threatened	
Bull trout (<i>Salvelinus confluentus</i>)	11/03/1992	ID, MT, NV, OR, WA, United States	• Steve Kelly Alliance for the Wild	• APA: Designate Critical Habitat • Listing:	

Showing 1 to 4 of 4 entries

< Previous 1 Next >

» Biological Opinions

Show 10 ▼ entries

BO date	Lead Office	Title	Activity Code	Project Type	Location

10/26/2020	Washington Fish and Wildlife Office	EWFO Mill Creek Flood Control Project Operations & Maintenance COE WW	01EWF00-2018-F-1709	Dam - Operations - Federal, Stream/Waterbody - Channel/Diversion Structures	Walla Wall (WA)
08/05/2020	Idaho Fish and Wildlife Office	Pettit Lake Creek Weir Construction Project	01EIFW00-2020-F-1121	Stream/Waterbody - Mod - Fish Passage Barrier Constr	Blaine (ID)
08/05/2020	Idaho Fish and Wildlife Office	Huckleberry Landscape Restoration Project	01EIFW00-2020-F-1101	Land Restoration / Enhancement - Forest	Adams (ID)
07/31/2020	Washington Fish and Wildlife Office	EWFO - Amended Settlement Agreement	01EWF00-2020-F-0004	Power Gen - Hydroelectric	Pend Ore (WA)

Showing 1 to 10 of 164 entries

[< Previous](#)
[1](#)
[2](#)
[3](#)
[4](#)
[5](#)
[...](#)
[17](#)
[Next >](#)

To see all Issued Biological Opinions please [visit the report](#)

» Life History

No Life History information has been entered into this system for this species.

» Other Resources

NatureServe Explorer Species Reports— NatureServe Explorer is a source for authoritative conservation information on more than 50,000 plants, animals and ecological communities of the U.S and Canada. NatureServe Explorer provides in-depth information on rare and endangered species, but includes common plants and animals too. NatureServe Explorer is a product of NatureServe in collaboration with the Natural Heritage Network.

ITIS Reports— ITIS (the Integrated Taxonomic Information System) is a source for authoritative taxonomic information on plants, animals, fungi, and microbes of North America and the world.

FWS Digital Media Library -- The U.S. Fish and Wildlife Service's National Digital Library is a searchable collection of selected images, historical artifacts, audio clips, publications, and video." +